Mani Amani

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EDUCATION

University of California San Diego (UCSD) and San Diego State University (SDSU) | August 2024 – August 2029:
> *Ph.D. in Engineering Sciences (Electrical and Computer Engineering)*
> *Advisors: Dr. Reza Akhavian (rakhavian@sdsu.edu) and Dr. Nikolay Atanasov (natanasov.ucsd.edu)*

University of California, San Diego (UCSD) | September 2018 - March 2023:
> *B.S. in Cognitive Science specializing in Machine Learning and Neural Computation*

EXPERIENCE

Research Assistant | SDSU and UCSD | Jun. 2023 – Present:
- Research Assistant at DiCE Lab at SDSU and the ERL lab at UCSD working on leveraging large language models and learning from demonstrations for robot behavior.
- Using ROS and Python to develop controls for robots such as Unitree Go1, Clearpath Husky, and dual UR5e arms for construction site deployments.
- Developing cost functions for safe Robot-Human object handling utilizing Q-Learning and REBA frameworks.
- Developed contrastive training models for modality encoders, enhancing AI's ability to recognize human activity.
- Implemented optimization algorithms for optimal human body ergonomics in human-robot object handover scenarios.
- Developed a custom inverse kinematics and REBA calculation framework for humanoid construction activity simulation inside the Unity game engine toward HRC ergonomic optimization.
- Created Improved multi-heuristic A* pathfinding algorithms to incorporate dynamic object avoidance using BIM models and artificial potential fields (APF).
- Developing IMU recurrent neural networks for real-time activity recognition.
- Developed a cyber-physical system for real-time multi-modal model inference for activity recognition for quadruped robots on construction job sites.
- Developed a self-labeling script to expedite the labeling of raw video and IMU construction activity data for ML training.

Research Fellow | San Diego Zoo and Wildlife Alliance | October 2024 - Present:
- Creating computer vision algorithms for detecting burrowing owls in their natural habitat and identifying predator animals
- Developing classifiers to detect whether the owl is a juvenile or an adult to further ensure accurate population observations
- Employing segmentation masks and analysis to determine the number of juvenile owls in each burrow to determine the proper conservation treatments can be employed.

Research Programmer | UCSD Physics Department | February 2020 – June 2022:
- Developed algorithms that use magnetic force, and angular velocity and applied Kalman filters for position estimation.
- Designed and developed Printed Circuit Boards (PCB) using Altium for an assortment of lab control units.

Instructional Assistant | UCSD Cognitive Science Dep. | Sep. 2020 – Dec. 2020:
- Instructed 45 students in Python, graded over 100 labs and exams, hosted office hours, and held 4 hours of discussion weekly.
- Received over 93% positive reviews from students in the course (COGS18).

Production Manager | UCSD Student Services | February. 2021 – September 2023:
- Oversaw a staff of 30 student technicians and event coordinator at the UCSD University Centers.
- Mixed and mastered audio and designed light effects for live concerts and events.

PUBLICATIONS

<u>Journal Papers</u>
1. **Amani, M.**, & Akhavian, R. (2024), "Intelligent ergonomic optimization in bimanual worker-robot interaction: A Reinforcement Learning approach". *Automation in Construction* (Published)
2. Palacios, A., In, V., **Amani, M.** (2024), "Disorder-Induced Dynamics in Complex Networks" *International Journal of Bifurcation and Chaos* (Published)
3. Palacios, A., Tamez, J. In, V., **Amani, M.** (2024), "Noise and Parameter Mismatch in a Ring Network for Sensing Extremely Low Electric Fields" *International Journal of Bifurcation and Chaos* (Published)
4. **Amani, M.**, & Akhavian, R. (202X). "Safe Pathfinding in BIM Worlds Utilizing Dynamic MHA*-APF Fusion Algorithms and Natural Language Processing" (Under Review)
5. Tavassoli, R., **Amani, M.**, & Akhavian, R. (202X). "Expanding Frozen Vision-Language Models without Retraining: Towards Improved Robot Perception". (To be Submitted).

Conference Papers

1. **Amani, M.**, & Akhavian, R. (2024), "Adaptive Robot Perception in Construction Environments using 4D BIM". The 2024 ASCE International Conference on Computing in Civil Engineering, July 2024, Pittsburgh, PA, USA (Published)

PROJECTS

Project Lead | Safe Pathfinding in BIM Worlds Utilizing Dynamic MHA*-APF Fusion Algorithms and Natural Language Processing | Jun. 2024 – Present:

- Created a script to generate APFs from BIM files autonomously.
- Developed a new heuristic to consider APFs during A* pathfinding.
- Created a pipeline for allowing LLMs to be able to give avoidance weights for the algorithm given different architectural objects dynamically depending on their linguistic and semantic danger levels.
- Results indicate an 82% increase in object avoidance in experimental test cases.

Project Lead | Adaptive Robot Perception in Construction Environments using 4D BIM | Nov. 2023 – Present:

- Cleaned and labeled raw construction activity video data collected by the lab for model training.
- Fine-tuned and validated CLIP models to better detect human construction activities utilizing specialized data.
- Developed a 4D BIM pipeline to extract construction schedules and detect low-level activities from the schedule.
- Created a cyber-physical system to ensure fast and reliable model inference of embedded system video streams on centralized server-side GPUs.
- Preliminary data shows higher confidence predictions for models leveraging BIM schedule data compared to models without.

Project Lead | Ergonomic Optimization in Worker-Robot Interaction: Circumventing the Discrete Nature of REBA Scores Using Reinforcement Learning in Virtual Reality | Oct. 2023 – Present:

- Developed a high fidelity inverse kinematic and REBA calculation framework to be used inside simulations.
- Developed a Q-learning regiment with specialized reward mechanisms to search for an optimal location for object handover.
- Developed a VR testing environment for human testing of the optimized scheme.

- Conducted experiments and collected and analyzed ergonomic score data.
- Preliminary data shows significant ergonomic optimization as compared to baseline heuristics.

Project Lead | Investigating the Efficacy of Shortcut Connections in ResNet Variants with Hybrid Binary Convolutions for Architecture Pruning Purposes | Mar. 2023 – May. 2023:
- Constructed an algorithm using hybrid binary ResNets in which competitive accuracy was maintained and memory usage was reduced by 50%.
- Project report with code can be found on my github.
- Potential applications in resource-constrained areas such as embedded systems requiring fast and cost-efficient computing.

Project Member | Expanding Frozen Vision-Language Models without Retraining: Towards Improved Robot Perception | Jun. 2023 – Sep. 2023:
- Designed and developed a contrastive learning objective to align Vision and IMU Encoders for frozen LLM inference.
- Contributed to testing and validation of different prompting structures and architecture for the most desirable inference results.
- Combined IMU and vision encoder had a 10% increase in activity recognition compared to singular encoders.
- The manuscript is submitted for review and publishing; preprint can be found on arxiv.

HONORS AND AWARDS
- Recipient of the NSF-Funded S-STEM ASSICS Scholarship, SDSU 2023
- Recipient of the SDZWA fellowship, 2024
- UCSD Provost Honors, 2018-2020